EGG TO ADULT DEVELOPMENT TIMES OF FIVE SPECIES OF CHIRONOMIDS (DIPTERA)[1]

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ABSTRACT: Development times were determined for 5 chironomid species collected from Eurasian milfoil, *Myriophyllum spicatum* L., a species introduced to North America, and mixed-native macrophytes in experimental ponds, Denton, TX.

Numerous studies have revealed that chironomid larvae occur abundantly on many aquatic plants (Menzie 1981, Keast 1984, Pardue and Webb 1985, Peets et al. 1994). Chironomids are an important link in energy transfers in aquatic ecosystems and constitute a major food source for many juvenile and adult fish species and other macroinvertebrates (Gerking 1962, Engel 1988). However, little is known about the biology of most of chironomid species. In order to provide development data necessary for production studies on larval chironomids, chironomid egg masses collected from field were reared to adults in a controlled laboratory environment. These data provide critical development times needed to interpret the life cycle of chironomid taxa.

MATERIALS AND METHODS

This study was conducted at the University of North Texas Water Research Field Station located in Denton, Texas. Constructed earthen ponds, often referred to as "mesocosms", were used for the field experiment (Kennedy et al. 1995). Each pond measures 30 m in length and 16 m in width and can be filled to a maximum depth of two meters. Water depth was maintained at approximately 50 cm during this study. Well water was used to compensate for evaporative losses during the study. In May 1998, five mesocosms were planted with the introduced macrophyte, Eurasian milfoil (*Myriophyllum spicatum* L.) and eight mesocoms were planted with mixed-native macrophytes.

Two different methods were used to collect egg masses. Sweeps were made through the water with fine meshed nets (mesh size: 250mm). Debris collected in the nets was examined for egg masses. In addition, individual plants were collected and attached egg masses were removed in the laboratory for rearing. Collections were made, usually in the mornings, between June and September 1999 from both native and Eurasian milfoil ponds. The collected eggs were placed in Petri dishes and reared in incubators at the constant temperatures of 15°, 20° and 25°C. All incubators had a 12L: 12D photoperiod. The chosen temperatures represented temperatures expected in the field. Egg masses were

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observed at least four times a day for hatching. First instars were transferred to mesh covered (mesh size: 600mm) plastic containers (12cm × 8cm), containing small rocks (4-6 cm diameter) and gravel (2-4 mm diameter) for substrate and filled with 50 ml of dichlorinated water that was gently aerated with air stones. Chironominae larvae were fed daily 0.5 ml of Tetramin (Tetra) fish food (Menzie, 1981) solution (approximately 5g Tetramin/100ml dechlorinated water). Predaceous Tanypodinae larvae were fed naidid oligochaetes, daily. Water was not changed but was added to the containers in order to compensate evaporation loss. Excess food was not removed.

Rearing containers were checked daily for adults. When an adult was found, the container was examined carefully for the larval or pupal exuviae for taxonomic associations. Larvae representing each instar were collected with a Pasteur pipette and preserved in 70% ethanol for taxonomic references. Instar determination was made by measuring head capsule widths and lengths with an Olympus Series Cue-2 image analyzer (Olympus, Tokyo) and Olympus SZH dissecting microscope. Date of emergence was recorded for each adult.

RESULTS AND DISCUSSION

Development times of five species are given in Table 1. As expected, for those species for which there are data from multiple rearing temperatures, generation times decreased at higher temperatures. *Apedilum elachistus* eggs collected in the field hatched within 2 days at 20° and 25 °C and in 4 days at 15°C. Larvae required an average of 23 days at 15°, 16 days at 20° and 11 days at 25 °C to complete its development from first instar to imago. The pupal stage lasted 3 days at 15 °C and within 1-2 days at 20° and 25°C. Based on the laboratory data one generation of *A. elachistus* could be completed in about 13 days at 25°, in 18 days at 20° and in 27 days at 15°C. The larval development rates for high temperatures (20-25°C) are similar to that (13 days, n = 6, T = 20-26°C) reported by Nolte (1995) for *A. elachistus* in South America.

Chironomus decorus completed a generation in 39 days at 15°, 27 days at 20° and 23 days at 25°C, whereas *Goeldichironomus holoprasinus* required 30 days at 20° and 22 days at 25° C to complete a generation. Eggs of *C. decorus* hatched in 4 days at 15°C and in 2 days at 20° and 25°C. The same egg development times were observed for *G. holoprasinus* at 20° and 25°C. Pupation took place within 3 days at 15 °C for *C. decorus* and within 1-2 days at 20° and 25 °C for both *C. decorus* and *G. holoprasinus*. The longer development times for *C. decorus* and *G. holoprasimus* compared to *A. elachistus* might reflect the large size of the species (Jackson and Sweeney, 1995).

Predaceous Tanypodinae larvae, *Larsia decolarata* completed one generation in 12 days at 20°C. Egg masses incubated at 15° and 25 °C for this species were not successfully reared to the adult stage. Eggs of *L. decolorata* hatched in two days, and pupation took place within a day at 20°C. *Tanypus neopunctipennis* required 49 days at 20°C, and 45 days at 25°C to complete a

generation. Eggs hatched within 2 days and pupation occurred in 3 days at 20°C, whereas it took a day for egg hatching and 2 days for pupal development at 25°C.

Most studies estimate egg hatching within a few days to a few weeks after oviposition (Menzie 1981, Ladle et al. 1985, Jackson and Sweeney 1995). Although the exact oviposition times are not known for the collected egg masses of the five chironomid species examined in this study, the development time ranged from 1 to 4 days after they were brought to the lab. Temperature constitutes a major controlling factor in egg development (Tokeshi, 1995) and egg development time generally decreases as temperature increases (Jackson and Sweeney 1995). Longer egg development times (4 days) were observed at 15°C whereas eggs incubated at 20° and 25°C completed development within 2 days.

Short development times observed in this study are in general agreement with other laboratory growth studies of chironomids. For example, Mackey (1977) measured growth and development of several species of chironomids in the laboratory at temperatures of 10, 15, and 20°. Development time at 15° ranged between 5 days for a small Orthocladiinae, *Cricotopus coronata* to 60 days for larger Chironominae, *Chironomus plumosus*. Menzie (1981) reported that *Cricotopus sylvestris* completed larval development in 28 days at 15°C and 10 days at 22° and 29°C in a laboratory rearing experiment, while the developmental time took 21 days at 18°C and 14 days at 22°C for the same species (Konstantinov 1958). Stites and Benke (1989) and Hauer and Benke (1991) conducted a study that simulated natural conditions (food, light, temperature) to obtain more realistic growth rates. They used specially designed growth chambers and reared early instars of chironomids. Their results tend to confirm the fast larval development rates observed in the laboratory in several studies (Mackey 1977, Menzie 1981, Jackson and Sweeney 1995).

Table 1. Development (egg to adult) times (in days) of chironomid taxa

Taxa	n (egg mass)	Mean ± SD	T (°C)
Apedilum elachistus Townes, 1945	5	27 ± 0.83	15 ± 0.5
	8	18 ± 0.88	20 ± 0.5
	8	13 ± 0.74	25 ± 0.5
Chironomus decorus Johannsen, 1905	4	39 ± 1.91	15 ± 0.5
	4	27 ± 1.70	20 ± 0.5
	5	23 ± 1.83	25 ± 0.5
Goeldichironomus holoprasinus Goeldi, 1905	4	30 ± 1.89	20 ± 0.5
	3	22 ± 0.81	25 ± 0.5
Larsia decolorata (Malloch, 1915)	2	12 ± 0.71	20 ± 0.5
Tanypus neopunctipennis Sublette, 1964	2	49 ± 0.70	20 ± 0.5
	1	45	25 ± 0.5

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